

Flood Hazard Mapping and Vulnerability Analysis of Hanumante Riverside Corridor Section

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Abstract

Urban development and Urban flooding are issues that are interlinked with each other and that can have serious effect on the settlement and the civilization of the urban population. As the pace of the urban development and Urbanization increases it increases the built-up areas and the impervious surface which eventually increases the risk of the urban flooding. This type of urban flooding causes major impacts near the riverside corridor and its catchment areas. The Riverside settlement areas are the always the vulnerable zones for the flooding in the river as well as the urban flooding in the settlement nearby it. The riverside corridor are those areas acting as the buffer zone for the settlement nearby the river and the river itself. Flooding can be Natural as well as human induced sometimes but the urbanization trends across the flooding plains on unmanaged way brings always the negative impacts on the lifestyle of the people through flooding. The main purpose of the research is to identify and mapped the flooding zone according to the setbacks assigned buffer zone or Areas with high risks, medium level risk buffer zone and low-level risk buffer zone according to the time lapse of the selected flooding zone. The research was carried out using the mixed methods of the time lapse satellite images to mapped vulnerable settlements and properly documented the increased of the buildup areas and carried out the questionnaire survey on those settlement about the vulnerability and impacts of the flooding on the lifestyle and the structures. As the research reviews the policies and others prevailing laws too for the new urban development across it.

Keywords

Flood, Urban Flooding, Land use Change, Madhyapur Municipality, Hazard Mapping, Vulnerability

1. Introduction

Every Human civilization emerges as the civilization near the riverside from the ancient history. Those rivers were prominent locations due to readily availability of drinking water and irrigation for the growing crops and also for transportation Purposes. The most notable examples are the Ancient Egyptians, who were based on the Nile, the Mesopotamian in the Fertile Crescent on the Tigris/Euphrates Rivers, the Ancient Chinese on the Yellow River, and Ancient India on the Indus. These river civilizations lead the major milestones for the development of the human race. Flood hazard is defined as probability of potential damaging flooding situations in a certain area within a specified period of time and conditions[1]. This hazard of flooding can have the through the contact directly from water, flooding itself and shifting of the river course channel. In terms of

both property damage and fatalities during the past century, flooding has always been one of the most destructing disaster for the Humans. Also, the Flood vulnerability involves the assessment of the “elements of risk” including human system, built environment and natural environment.

River corridors consists of an area within and adjacent to the present River course channel where Seasonal flow and Water channel evolution are most likely to occur. These areas used to have a great deal with the damage occurring during the flooding. River Corridor can be defined as the land area adjacent to a river that can have a certain dimensions, slope, and buffer of the natural water channel. These river corridors are always vulnerable to flooding during the monsoon and have a risk to the infrastructures near them. Thus, there is the ultimate need for river corridor management. This type of management merely depends upon the river geography, spacial geology, valley shape, and slope of

the river flow. Also, these river plains are always the target for various human encroachment. so these river corridors need to be properly maintained considering all the landscapes and infrastructures around them to minimize the risk and damage caused by the rivers.

Flood hazard areas are those areas across the floodplain that may be Overrun by a range of flood frequencies up to and including the small change of annual flood (i.e. base flood). Due to rapidly growing settlements and a growing number of infrastructures the risk of urban flooding is high during the monsoon period. The flooding scenario is changing due to the urbanization trend and the growing number of settlements due to the increase in population in urban areas.

The identification of the flooding hotspots is the crucial steps to be followed at first. These hotspots are those areas with the potentiality financial losses and Life casualties with requires necessary immediate or long-term mitigation actions plans[2]. Those Mitigation strategies include urban planning, Possible relocation policies, Restricted territory demarcations, and also actions aiming for increasing public awareness[3].

2. Study Area

The selected study area lies in the Madhyapur Thimi Municipality of Bhaktapur District along the stretch of the Hanumante River of the Bagmati Province of Nepal. It lies between 27°40'0" and 27°42'0" Northing, and 81°22'30" and 85°25'0" Easting[4]. It occupies a total area of 11.47 square kilometers. River Hanumante Khola demarcates Western boundary with Lalitpur District's bordering area like Imadol, Tikathali, and Balkot. Surya Binayak Municipality of Bhaktapur district demarcate its southern border along Hanumante Khola. Bhaktapur Municipality and Changunarayan Municipality lies on the east and northeast respectively[4]. Due to its location almost in the middle of the three major cities of the Kathmandu valley i.e. Lalitpur, Kathmandu and Bhaktapur, it was named "Madhyapur" which means mid-town. [noitemsep] It is the fastly growing municipality in the Bhaktapur District. It is an historical town with an elevation of 1326 meter. Due to good availability of the services like transportation, health, education etc. pace of urbanization is taking up rapidly in recent years. After 1950, various important educational center like Janak Education Material Centre, Education campus of TU, Central School

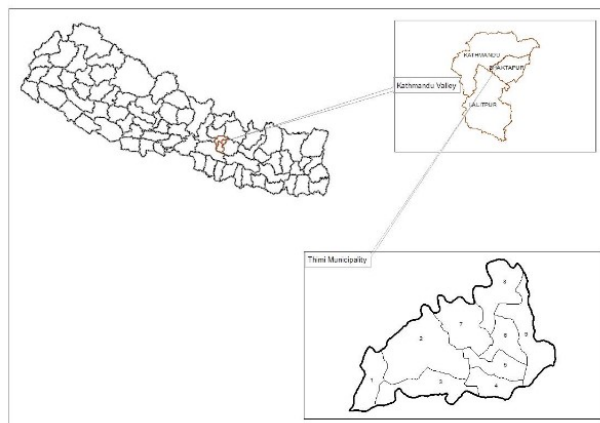


Figure 1: Map of Madhyapur Thimi Municipality
Source: Madhyapur Thimi Municipality

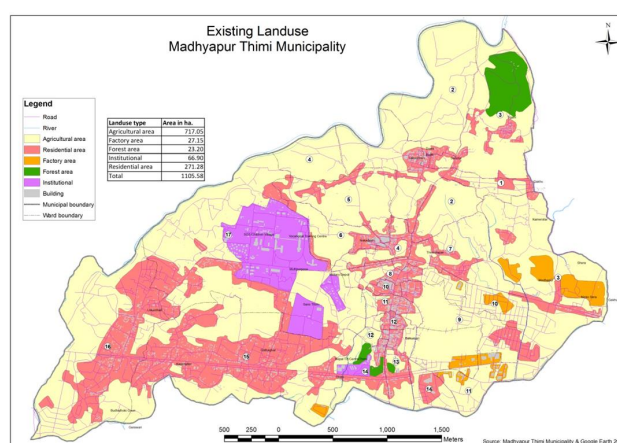


Figure 2: Existing Landuse Map of Madhyapur Thimi Municipality
Source: Madhyapur Thimi Municipality

Examination Control Board, CTEVT and establishment of Nepal Tuberculosis Hospital, several schools and colleges were established at Sanothimi may have attracted people to municipality[5] This area taken into consideration is the flood prone zone stretched from the Hanumante bridge of the Naya Thimi, Bhaktapur to the Radhe radhe area which would be around stretch of the 3 km span. So the flood prone mapping and the possible urban development scenarios would be studied along this span.

3. Objectives

The main objectives of this study is to estimate the flood hazard mapping of the selected section with the tool of the GIS mapping from the past to the present times. The specific objective of the study includes:

- Flood Vulnerability Mapping and Change in

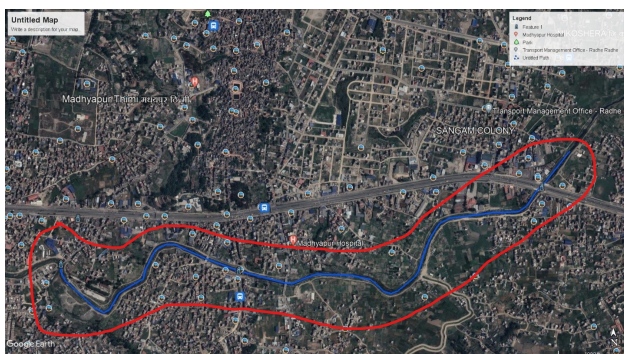


Figure 3: Red boundary area shows the stretch of the flooding zone taken as site across Hanumante river

Built-up area

4. Data Used

The data used in this study are

- Satellite Data
 - Google earth satellites images of 2005, 2010, 2015 and 2022
- GIS Data – (From department)
 - Municipal Boundary
 - River Network
 - Road Network
 - Building Footprint
- Other data
 - Population Census data from the Municipality

5. Methodology

This study was performed with the validation of interpretation of the Site observation and literature study. The mixed method of data collection from the primary as well as the secondary data sources. Firstly, the preliminary study of the site and the sire area was done with the available literature and the various reports, data collected from the municipality, High Powered Committee for Integrated Development of Bagmati Civilization (HPCIDBC), KVDA. Interviews and Reports from these institution helps in preparation of the initial study of the flooding zone across the Hanumante River. For the identification of the flooding zone past records of the flooding areas across the Hanumante river basin is identified. The real site

Table 1: Houses under Buffer zones

Year	Houses Number		
	Buffer 20 Meter	Buffer 50 Meter	Buffer 70 Meter
2010	25	88	104

inspection of the identified flooding zone and marking of the identified houses lying on the river setback lines and the houses with possible risk of flooding in the map are done. This shows the vulnerability and Flood hazard assessment of the site. Post processing includes the creating map of the houses number lies within the setback line and the buffer zone for the level of vulnerability and hazards. This vulnerability assessment was done to investigate the physical vulnerability of the population nearby the riverside and change of the build-up area according to the time lapse.

6. Results and Discussion

The map presented shows the vulnerability of the settlement near the riverside with the marking of the buffer zone of 20M, 40M and 60M within it. This map used to mark the houses that are in immediate risk, medium risk and Low risk of flooding in the current scenario. In addition, it analyses the change in the build-up areas across this zone too.

6.1 Flood Vulnerability and Hazard Mapping

This vulnerability map and hazard analysis map is prepared by modelling the current land use map with the help of the google satellite photos and verification from the site visit. The assessment of the flood area within the 20M setback lines lies on the most vulnerable area within the riverside along with the cultivation area. The other zone marking of the buffer zone lies with the medium and low level of risks. This type of vulnerability of the flood area shows that most of the vulnerable area lies in the urban areas which can have considerable impact in the lifestyle of the people in the settlement. This mapping is done with the year 2010, 2015 and 2022 with the changes in the house number and Buildup areas which were Geo-referenced with the National Coordinate System.

7. Conclusion and Recommendations

This study shows the process to prepare the flood vulnerability settlement that lies across the riverside

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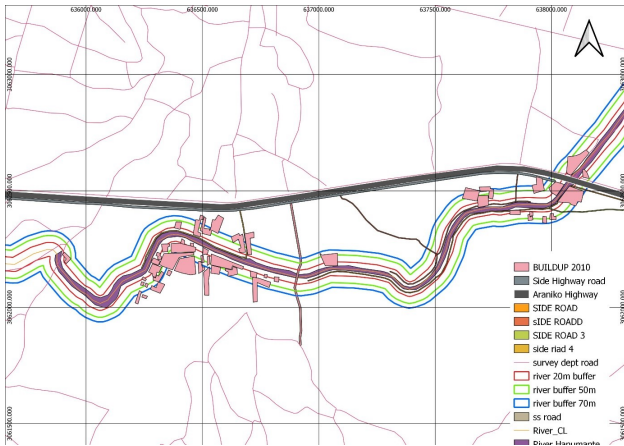


Figure 4: Hazard Mapping of Year 2010

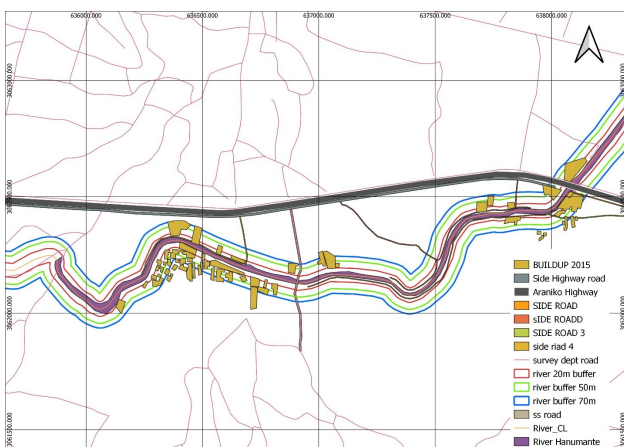


Figure 5: Hazard Mapping of Year 2015

Table 2: Houses under Buffer zones

Year	Houses Number					
	Buffer 20 Meter	% Change from 2010	Buffer 50 Meter	% Change from 2010	Buffer 70 Meter	% Change from 2010
2015	14	-44%	105	+19.31%	149	+43.26%

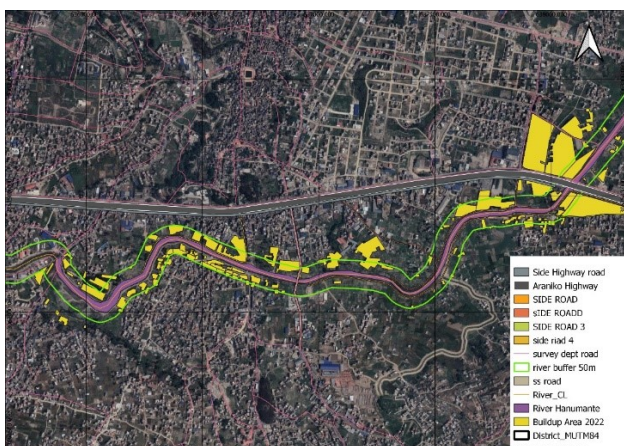


Figure 6: Hazard Mapping of Year 2022 in 20M Buffer

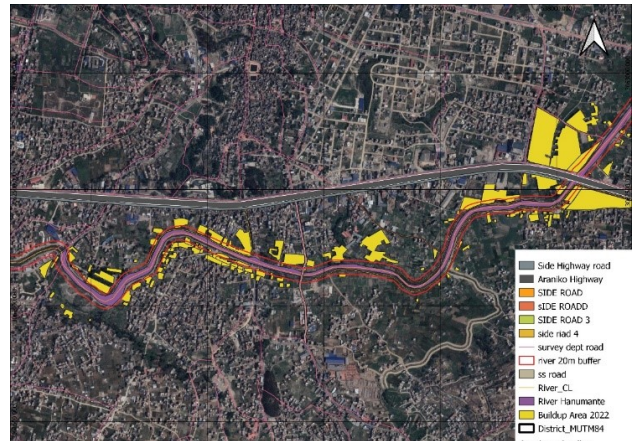


Figure 7: Hazard Mapping of Year 2022 in 50M Buffer

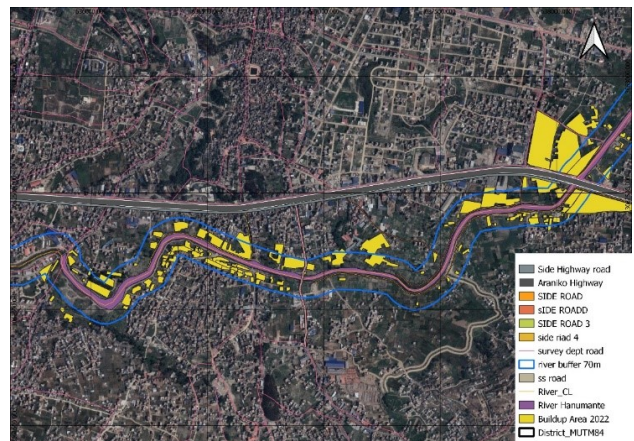


Figure 8: Hazard Mapping of Year 2022 in 70M Buffer

Table 3: Houses under Buffer zones

Year	Houses Number					
	Buffer 20 Meter	% Change from 2010	Buffer 50 Meter	% Change from 2010	Buffer 70 Meter	% Change from 2010
2022	49	+71.42%	194	+84.1%	315	+52.69%

settlement with the application of the satellite images and GIS Applications. This study helps to identify the possible assessment of the vulnerability and number of houses that comes under these hazards of flooding. This helps in making the various decision making and possible evacuation and planning during the flooding situation.

This flood vulnerability was assessed about the land use pattern in the study area. The percentage of the change in the Build-up area shows the increasing risk of the flooding damage in the site causing the increase number of casualty and damages each year. Each year flooding increases the risk of loss of life and property within the site due to poor infrastructure and lack of flood resilient planning.

The flood hazard assessment can also be interpreted as means for the proper evacuation as well as resilient planning for the municipality and the concerned authorities. Riverside corridor are the crucial areas of the urban areas that must be resilient as well as people should have proper knowledge about the possible flooding scenarios and its impacts on the daily lifestyles of the people.

Thus, the mapping of the settlement in accordance with

their level of vulnerability helps in the development of the settlement planning, land use planning, Land development and disaster planning etc

References

- [1] Bruno Merz, AH Thieken, and Martin Gocht. Flood risk mapping at the local scale: concepts and challenges. In *Flood risk management in Europe*, pages 231–251. Springer, 2007.
- [2] Raffaele De Risi, Fatemeh Jalayer, Francesco De Paola, Stefano Carozza, Nebyou Yonas, Maurizio Giugni, and Paolo Gasparini. From flood risk mapping toward reducing vulnerability: the case of addis ababa. *Natural Hazards*, 100(1):387–415, 2020.
- [3] Fatemeh Jalayer, Raffaele De Risi, Alphonse Kyessi, Elinorata Mbuya, and Nebyou Yonas. Vulnerability of built environment to flooding in african cities. In *Urban Vulnerability and Climate Change in Africa*, pages 77–106. Springer, 2015.
- [4] Sarita Shrestha. *Water quality assessment of public wells of Madhyapur Thimi municipality*. PhD thesis, Central Department of environment science, 2008.
- [5] Pujita Shrestha and Sudarshan Raj Tiwari. The impact of increased urbanization on urban flooding: A case study of madhyapur thimi municipality. In *Proceedings of IOE Graduate Conference*, 2019.